

Utility Guide to Rainwater/Stormwater Harvesting as an Adaptive Response to Climate Change

Proposal for Funding Opportunity No. R11SF81307

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Technical Proposal and Evaluation Criteria

Executive Summary

The proposed project contributes to accomplishing the goals of Task Area C, *Assessing and evaluating natural or cultural resources management practices and adaption opportunities*. Relatively little guidance exists on how public utilities and agencies can evaluate the suitability and cost-effectiveness of water harvesting strategies to provide tangible and significant benefits to the community. This project will develop guidance for use in assessing and planning water harvesting at multiple scales in multiple sectors, to help meet the challenges of managing water resources under conditions of changing climate and increasing demands. This project will form the thesis work of a Master's student under the supervision of the PI and co-PIs with considerable input and guidance from a Technical Advisory Committee (TAC). The TAC will consist of experts in water harvesting and climate change from government agencies, the development community, nonprofit organizations, and the academic community. The TAC will meet in Fall 2011 and quarterly thereafter to help guide project development and review products. In addition, these experts will be available for consultation throughout the project, providing data and advice. The critical impacts of climate change on water supplies include potential changes in rainfall availability, frequency, and magnitude; evapotranspiration; flood control and stormwater management needs; and plant water needs at multiple points in the future. These impacts complicate planning for the needs of rapidly growing populations. Guidance will be designed for use by water utilities, stormwater management agencies, flood control agencies, and other public departments that obtain, deliver, or otherwise manage potable water, rainwater and/or stormwater in the urban environment of the Western US. Efforts will focus on Tucson, Arizona, which is broadly representative of growing cities in the desert Southwest. Based on the specific conditions and experience in the greater Tucson area, a prototype assessment tool and supporting guidance will be developed to lead users through research, data gathering, benefit-cost analysis, and evaluation steps.

Technical Project Description

Project Goal

The project goal is to develop a prototype guidance tool for public utilities and agencies to use to evaluate the suitability and cost-effectiveness of rainwater and stormwater capture at various scales for multiple benefits to the community.

Enhancement of Management of Natural and Cultural Resources

The Arizona Governor's Blue Ribbon Panel on Water Sustainability convened in 2010, met monthly over almost a year to discuss Arizona's needs. Deliberations resulted in a list of recommendations including recommendations for research to be undertaken by the state universities. One of the proposed priority research areas is "Rainwater Harvesting & Stormwater Research". The Panel recommended that universities take responsibility for leading research, *"to identify regulatory barriers, cost and benefits, water quality issues and avenues for increasing utilization of stormwater and rainwater at the regional, community and individual property level."*

The assessment tool and guidance will provide much needed assistance in assessing the cost effectiveness of rain water and storm water capture in the Desert LLC. The changing climate and other pressures are prompting communities across the country to look at water harvesting as a management option. A potentially important water management strategy, it is expensive relative to the cost for other water sources. It has become a truism among knowledgeable utility managers that at any reasonable price for water, it is impossible to recoup the cost of water harvesting systems in water conservation savings. However, this has not dimmed the appeal of water harvesting as a management tool because of its potential for achieving multiple community benefits. For example, at the neighborhood scale, curb cuts and similar ground surface alterations not only potentially reduce water demand for residential outdoor watering, but also can reduce impacts of flooding from intense storms, provide a cost-effective way to comply with non-point source pollution regulations, and allow for implementing urban forest practices that can improve neighborhood quality of life. With these added benefits, the outcome of a benefit-cost analysis can change for many communities.

Project Schedule

With a start date of November 1, 2011, the final products: draft research report, inventory, data base, prototype assessment tool, and PowerPoint presentation, will be completed for dissemination in August 2013. An additional two months will be used to initiate project dissemination, and a report of these efforts will be in the final research report. The proposed project will create the prototype necessary to demonstrate the usefulness of the concept to utilities, funders and others. We see the proposed research as ultimately yielding a program that will include two or more additional years of testing and refining based on interest and input from multiple regions throughout the Desert LCC. The concept is so timely that we anticipate few difficulties in securing additional funding. Through these efforts the assessment tool can become more easily transferable to other western regions and potentially other parts of the country.

The project will have five overlapping stages:

1. Research design and planning;
2. Data gathering and consultation;
3. Preparing and testing draft assessment tool;
4. Preparation of final project outputs: and
5. Dissemination of research results, including the prototype tool and guidance.

Each of the five stages is broken out into individual tasks below.

Stage 1. Research design and preliminary planning: Months 1-7

1.1 Convene a Technical Advisory Committee (TAC), which initially will help to refine the scope of the project; identify data sources and commit to providing data; and later will be asked to review progress, suggest new data sources, supply advice on data, data collection and data coding. We anticipate holding quarterly meetings of the TAC.

- 1.2 Make initial presentation of the project concept and scope of work at a meeting of the local network of rainwater and stormwater professionals (30+ participants) scheduled for Fall 2011. The meeting will provide an opportunity to gather additional feedback from experts not directly engaged in the project;
- 1.3 Identify the key parameters relevant to the assessment including categories of costs, relevant benefits and potential barriers other than cost;
- 1.4 Develop a draft prototype decision model (equations for benefit-cost analysis calculations and spreadsheets) for data input and analysis;

Stage 2. Data gathering and consultation: Months 3-12

- 2.1 Inventory existing resources and conduct a literature review of rainwater/stormwater harvesting practices, costs, benefits and constraints from local, state, regional, national and international sources. At this stage no attempt will be made to evaluate the quality of the resources;
- 2.2 Collect data from sources identified in consultation with individual members of the TAC and other water resource managers and officials whom they suggest. Data will be sought on costs associated with water harvesting; relevant regulations, codes and laws; existing infrastructure; and other regionally specific data;
- 2.3 Organize a workshop in conjunction with AridLID 2012, a Southwest-regional conference focusing on the sustainable management of stormwater through the use of green infrastructure and low impact development. The conference is in its planning stage now and will be held in Tucson on March 27-29, 2012. The workshop will introduce the guidance tool concept to an audience broadly representative of water managers across the Southwest and engage them in providing input on the study approach;

Stage 3. Preparation and testing of the draft assessment tool: Months 10-20

- 3.1 Populate the model with existing data and reasonable assumption where data is lacking. Reasonable assumptions will be arrived at by consensus of the TAC;
- 3.2 Hold three meetings of the TAC to review progress, provide input, and approve the prototype assessment tool and guidance for testing;
- 3.3 Make use of the TAC to identify and engage managers at water utilities, public works departments and other jurisdictions and agencies that manage water supplies for face-to-face meetings to test the draft assessment tool;
- 3.4 Establish testing protocols, including types of interactions, record keeping, and evaluation criteria;

3.5 Hold face-to-face meetings to work through the steps defined in the draft assessment tool. Interactions and record keeping will be carried out in accordance with protocols, and with requirements for human subject's research of the Department of Health & Human Services (HHS) and Office for Human Research Protections (OHRP) through the UA Institutional Research Board.

Stage 4. Preparation of final project outputs: Months 18-22

4.1 Modify and refine the assessment tool based on lessons learned during the tests and feedback from water resources managers;

4.2 Prepare final products, including the draft project report, prototype assessment tool, guidance on tool use, and a PowerPoint presentation of the concept, research results, and prototype tool;

4.3 Hold final meeting of the Technical Advisory Committee for review of final products.

Stage 5. Dissemination of project outputs: Months 22-24 (Interim papers and presentations: Months 12-24)

5.1 Implement dissemination plan described below. Much more than two months is expected to be used for information dissemination. We expect that there will be a great deal of interest in our results and we will be asked to present the concept and/or introduce the assessment tool. Our association with Cooperative Extension provides a pathway to continue dissemination activities after the project is over. We also expect that the TAC members will actively disseminate results within their spheres;

5.2 Prepare research papers and posters;

5.3 Make presentations at relevant conferences, such as American Water Resources Association or American Water Works Association;

5.4 Deliver final report, including preliminary report on dissemination, and other project outputs to the US Bureau of Reclamation WaterSMART program for the Desert LLC;

5.5 Present PowerPoint presentation at the semi-annual meeting of the Rainwater-Stormwater Professionals Network (RSPN) a group of water and climate scholars and professionals recently initiated and with the support of the WRRC.

Anticipated Difficulties

Everyone involved in water harvesting deplores the lack of data. The project will assemble all available data. Beyond their high level of expertise, the project personnel, consultants, and TAC represent a network of professional who are aware of and/or have access to the existing sources of primary data in the Tucson region. However, there will inevitably be gaps. The expertise of the TAC will be invaluable in offsetting the lack of data with reasonable assumptions, but data gaps identified in this project will need to be filled for future use of assessment tools. An added benefit of this project is the identification of those gaps as input to the research agenda.

Prior Studies

The proposed project will draw on the results of a few prior and on-going studies for individual components of the assessment tool and supporting guidance.

In climate change, the SECURE Water Act Report (2011) produced by Reclamation provided a few estimates of the impacts of climate change on the lower Colorado River Basin. They estimated that on average, temperature in the basin could increase by 5–6 °F in the next century. Decreases in precipitation (1.6 percent) and mean annual runoff (8.5 percent) are expected by 2050, with seasonality of runoff shifting from the April-July to December-March period. This shift could mean less water for irrigation and possibly hydropower at the same time warmer temperatures are causing higher rates of evaporation and plant water use. On-going studies under Reclamation's WaterSMART program in the Colorado River basin will refine these preliminary estimates through a detailed basin study in the Colorado River Basin (*SECURE Water Act Section 9503(c) - Reclamation Climate Change and Water 2011, Section 2 - Basin Report: Colorado*, available online at www.usbr.gov/climate.)

In the area of water quality, a collection of studies is underway to determine how landscape and rainfall characteristics affect solutes in runoff, surface water and groundwater. The project *Tradeoffs of Enhanced Urban Runoff-Recharge and Water Quality* (Erika Gallo, Post-Doc, UA School of Natural Resources and the Environment) is finding out if pollutants, metals, pathogens and nutrients in storm runoff present a challenge to stormwater recharge.

The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental, and Social Benefits was produced by the Center for Neighborhood Technology and is available at <http://www.cnt.org/repository/gi-values-guide.pdf>. It based on a matrix of green infrastructure practices, including rainwater and stormwater harvesting, and types of benefits, the authors attempted to quantify the value of benefits for each practice. Instructions and examples are provided so that individuals and organizations might quantify the benefits of a particular practice for their particular situations.

Some information is provided on the web sites of ARCSA and the International Rainwater Catchment Systems Association. These are professional organizations that publish reports on associated topics. They make some of their content available to the public. Harvest H2O for reports (<http://www.harvesth2o.com/>) is an industry-sponsored site that provides news on water harvesting. There are also many how-to guides for planning and

implementing residential and commercial scale water harvesting, two particularly pertinent such guides are the City of Tucson's *Water Harvesting Guidance Manual* published in 2005 and Texas A&M University Cooperative Extension's Water Harvesting web site <http://rainwaterharvesting.tamu.edu/>. These guides often contain calculators for water yield. Less frequently there are calculators for water needs, which require more site-specific information and can be very complicated. Cochise County Cooperative Extension is refining a rainwater harvesting water needs calculator suitable for southeastern Arizona, which the project will be able to draw on before it is made more widely available.

Other current projects that the project will tap into include:

- Urban Land and Water Use in the Desert Southwest, Steve Yool, Chris Scott, Stephanie Beuchler, UA, School of Geography and Development, Sharon Megdal, WRRRC. Funded 2010.
- Outdoor Water Conservation Demonstration, Maricopa County Cooperative Extension office, Phoenix, Summer Waters, Water Resource Agent, Maricopa County Cooperative Extension and Kitt Farrell-Poe, Arizona Cooperative Extension Water Quality Coordinator, UA Department of Agricultural & Biosystems Engineering
- Multiple partners including Reclamation and UA have funded an extensive water harvesting demonstration at the Tucson Nature Conservancy office that also includes a web site: [rainharvest help.org](http://rainharvesthelp.org).
- Spatial Optimization for Regional Stormwater Infrastructure, Gary Woodard, Associate Director for Knowledge Transfer, UA Biosphere 2.
- Harvesting Rainwater from large Photovoltaic Arrays, Gary Woodard, Associate Director for Knowledge Transfer, UA Biosphere 2.

Sources for Non-Federal Funding

The UA Water, Environmental and Energy Solutions (WEES) initiative, funded through the state Technology and Research Initiative Fund (TRIF) will provide funding for operations to total \$8,657. In addition, the PI salary match shown for S. Eden and J. Moxley will come from WEES-TRIF.

The source of the salary match of co-PI S. Megdal is the State of Arizona.

Salary match is also being provided from members of the Technical Advisory Committee. UA faculty and staff salary matches come from the State of Arizona; matching funds from other TAC member organizations are Pima County and the City of Tucson.

Project Evaluation Criteria

Technical Merit

Project Scope

- The proposed project contributes to accomplishing the goals of Task Area C, *Assessing and evaluating natural or cultural resources management practices and adaption opportunities*. Relatively little guidance exists on how public utilities and agencies can evaluate the suitability and cost-effectiveness of water harvesting strategies to provide

tangible and significant benefits to the community. This project will develop prototype tools for use in assessing, planning, and implementing water harvesting at multiple scales in multiple sectors, to help meet the challenges of managing water resources under conditions of changing climate and increasing demands.

- The study will focus on the Tucson region as a case study. Tucson is an ideal region in which to initiate the proposed project. It falls within the Desert LCC and is broadly representative of other metropolitan areas in that area. The City of Tucson and Pima County are leaders in water harvesting nationwide and the area contains an unusual concentration of experts in the field. Water harvesting professionals in the Tucson area have already identified the need for better coordination and better information sharing, and efforts are underway to develop a network of professionals who meet regularly to enable more efficient progress toward establishing and meeting water harvesting goals for the community. Many of these professionals have agreed to be members of the Technical Advisory Committee for this project.
- The primary objective of the proposed project is to provide proof of concept for an assessment tool that will enable water managers to determine at what scale and with what strategies rainwater and/or stormwater harvesting would be appropriate and cost effective. Tucson is a national leader in water harvesting, yet the utilities lack essential guidance on how to evaluate its feasibility and cost effectiveness for their particular needs. The lack of resources is especially acute in the arid Southwest, where major rivers can be intermittent / ephemeral or effluent dominated for much of their length; where water managers are challenged by conditions of changing climate and increasing demands. Water harvesting provides one potentially important tool for water managers to advance the goals of conservation and provide multiple additional benefits in urban areas. Among the many potential benefits is enhanced habitat for urban wildlife potentiated by more effective use of rainfall.
- The critical impacts of climate change on water supplies include potential changes in rainfall availability, frequency, and magnitude; evapotranspiration; flood control and stormwater management needs; and plant water needs at multiple points in the future. In arid south-central Arizona, assessments of climate variability and change impacts include higher temperatures, longer growing season, less rainfall in the cooler months and more intense storms in the summer months, and potentially longer periods of drought. These impacts complicate planning for the needs of rapidly growing population. The proposed project will incorporate trends in climate among the factors a utility should consider when assessing the usefulness of water harvesting, using the latest data and projections from global model downscaling. In this way, the proposed assessment tools will prepare utilities contemplating water harvesting to understand the impacts of climate trends on their assessments.
- In order to reach the project objective, the project team will undertake the tasks described in the project schedule above. The following timeline displays those tasks within the five stages identified above.

Project Timeline	2 0 1 2												2 0 1 3													
November 2011-August 2013	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O		
	o	e	a	e	a	p	a	u	u	u	e	c	v	e	a	e	a	p	a	u	u	u	e	c		
	v	c	n	b	r	r	y	n	l	g	p	t		c	n	b	r	r	y	n	l	g	p	t		
TASKS																										
<i>Stage 1- Design</i>																										
1.1-Convene TAC																										
1.2-Present concept to RSPN																										
1.3-Identify parameters																										
1.4-Develop conceptual decision model																										
<i>Stage 2- Data Collection</i>																										
2.1-Inventory resources																										
2.2-Collect and compile data																										
2.3-Organize & conduct workshop																										
<i>Stage 3 – Preparation & testing:</i>																										
<i>Assessment tool</i>																										
3.1-Populate model																										
3.1-Consult TAC																										
3.3-Identify assessment tool testers																										
3.4-Establish test protocols																										
3.4-Carry out face-to-face tests																										
<i>Stage 4 – Preparation:</i>																										
<i>Final outputs</i>																										
4.1-Revise assessment tool & guidance																										
4.2-Prepare final project outputs																										
4.3-Hold final TAC meeting																										
<i>Stage 5 - Dissemination</i>																										
5.1-Implement dissemination plan																										
5.2-Prepare research papers & posters																										
5.3-Make conference presentations																										
5.4-Deliver final report																										*
5.5-Present to RSPN																										
Percent of total budget by task (Sums between 65% and 130% of effort)																										

Ability to Accomplish Scope

Percent of budget allocated to each task is displayed on the timeline above.

The project team consists of Dr. Susanna Eden, Coordinator for Applied Research at the WRRRC, Jacqueline Moxley, Program Director for the UA WEES program, and Dr. Sharon B. Megdal, Director of the WRRRC. All three have offices in the WRRRC facility at the University of Arizona campus in Tucson, Arizona. The graduate student, Jenna Cleveland, recently began her studies at UA for a Graduate Certificate in Water Policy. In addition, a Technical Advisory Committee is being formed, with membership commitments from 10 experienced professionals in rainwater and stormwater harvesting and related fields.

Synopsis of Team Member Credentials

Susanna Eden, Coordinator, WRRRC Applied Research

Dr. Eden received her PhD in Water Resources Administration from the University of Arizona. Her research focuses on use of scientific information in decision making and decision processes. She has a comprehensive understanding of Arizona water issues and has written for various audiences on specific issues such as the water-energy nexus,

desalination, water reuse, water transfers from agriculture to urban use, and groundwater recharge. She managed a groundwater recharge planning process in the Tucson region for the State of Arizona. Before returning to the WRRRC, she served as Secretariat for the Global Water Cycle Program at the US Global Change Research Program in Washington, DC, which coordinated federal agency research efforts to understand and respond to climate change and related challenges.

Jacqueline Moxley, Program Director, UA Water, Environmental and Energy Solutions
Ms. Moxley has a BSc and MSc from the University of Guelph, Ontario, Canada. She has been involved in water resource issues in Arizona at the WRRRC for the last nine years. She coordinated the Water Sustainability Program, a program on water research, education and outreach and is now lead for the Water, Environmental and Energy Solutions initiative, a multi-million dollar grant program funded through the state Technology and Research Initiative Fund. She serves on the UA President's Advisory Council for Environmental Sustainability. Recently, she was the recipient of a grant from the UA Green Fund to install a rainwater harvesting demonstration at the WRRRC. She is currently leading a WRRRC initiative to centralize water harvesting information for the public and identify research and information needs.

Sharon Megdal, Director, WRRRC

Dr. Megdal received her PhD from Princeton in Economics. In addition to her role as WRRRC director, she is a Professor in the Department of Agricultural and Resource Economics and the Department of Soil, Water, and Environmental Science and serves as Co-Director of the UA Water, Environmental and Energy Solutions initiative, which is funded by the Technology Research Initiative Fund (TRIF). In 2010, Dr. Megdal was named Distinguished Outreach Professor. Her work focuses on state, regional and transboundary water resources management and policy, on which she writes and frequently speaks. Current projects include: water planning and management in growing, arid regions; mechanisms to secure water for environmental needs; and water pricing.

Jenna Cleveland, Graduate Student, WRRRC

Jenna Cleveland is currently pursuing the Graduate Certificate in Water Policy at the University of Arizona. She works at the WRRRC, where over the summer she helped to organize a roundtable discussion on water harvesting in Tucson and the surrounding area. This roundtable resulted in a growing network of academics and professionals who are involved with water harvesting and who have expressed the desire to work in a coordinated way on the effort. As a lead-in to the roundtable, Jenna developed a resource guide to water harvesting information from local, regional, and national sources, and compiled lists of demonstration sites, participant expertise directory and local water harvesting projects.

The synopses of TAC members' credentials follow at the end of this section.

The University of Arizona Water Resources Research Center is uniquely positioned to take on and coordinate this project. One of the WRRRC's key roles is to provide a nucleus for the activities of multiple participants from the UA, government and the private sector in water

policy and planning research and assessment. As Coordinator for WRRRC Applied Research and Program Director for WEES, Eden and Moxley work together daily building and supporting networks of academics and other professionals, as well as students and members of the public. Both have led and/or participated in several projects of similar scope, including projects for and in collaboration with Reclamation. Megdal has a long record of leading research grant projects and regional efforts to inform local, regional, and state water planning and policy.

In addition, WRRRC has played a role over the years in fostering the development of water harvesting curricula, applied research and demonstration sites, public education and outreach to water managers and residents. There is a wealth of expertise in the local community with a long history of water harvesting, including non-profit companies and NGOs, commercial interests, and government agencies. The WRRRC is a respected member of this community of experts for our efforts at providing coordination and information dissemination. Many of these experts have committed their time to the proposed project because from their perspective, it is a vitally important project and the WRRRC is the appropriate body to lead it.

The following example illustrates the WRRRC's past experience with projects of this type for Reclamation. The WRRRC created a program called Conserve to Enhance (C2E) as part of a project funded through Reclamation. The program links water conservation efforts with watershed restoration to provide water users assurance that their water conservation will translate into benefits for the environment. Participants implement conservation practices, and donate the monetary equivalent of their water savings to environmental restoration and preservation projects. The program is unique for water in the West and has attracted the attention of utilities as far away as Denver, Colorado, in addition to many communities in Arizona. The WRRRC now co-manages the program with Watershed Management Group and the Sonoran Institute. The WRRRC and partners launched a pilot program in January 2011. Funds provided by the Environmental Protection Agency are being used to subsidize the installation of water harvesting features at the homes of 45 pilot participants—customers of Tucson Water. As a program that began by creating a prototype to attract follow-on funding, it is similar to the proposed project; private grant funds are expanding the reach of C2E beyond Tucson.

The project team has an established record of many years' standing working together on research and outreach projects. They have strong ties with the water and environmental management community in Arizona and a reputation for objectivity and integrity. The talented graduate student who will be employed by the proposed project has met and interacted with water harvesting professionals who will be involved as members of the TAC and the interested larger community, and is familiar with the issues. The TAC is eager to see a successful outcome to the project and are members of the professional network initiated in June 2011, that would be developing concurrently with the proposed project. The Desert LCC and Reclamation will seldom find a team better capable of proceeding with the proposed tasks immediately upon entering into a financial assistance agreement.

Technical Advisory Committee Members - Credentials

Ann Audrey, Environmental Consultant

Ann Audrey has master's degrees in Water Resources Administration and has taken advanced training in permaculture design. She is currently an environmental consultant working on projects involving rainwater harvesting, urban forestry and habitat restoration. From 2006 to 2009 she was the Environmental Projects Coordinator at the City of Tucson's Office of Conservation and Sustainable Development where she assisted developers in implementing voluntary rainwater harvesting guidelines and helped develop Tucson's innovative new regulations requiring commercial sites to meet 50 percent of landscape water demand using harvested rainwater. While at the City, she also worked on riparian protection regulations, wildlife corridor planning and invasive species control. Ann came to the City from Tucson Audubon Society, where as Manager of Habitat Restoration Projects, she used sustainable design techniques and rainwater harvesting to plan and implement large-scale riparian restoration projects. Previous work includes water resources planning at the Arizona Department of Water Resources and technical staff-work at a hydrogeology consulting firm.

Evan Canfield, Chief Hydrologist, Pima County Regional Flood Control District

Evan Canfield holds a PhD in Agricultural Engineering from the University of Arizona with a minor in Hydrology. His primary water-related skills are understanding rainfall runoff relationships, plant-water requirements and irrigation. He is also a registered Professional Civil Engineer. As a member of Pima County's Core team on the City of Tucson/Pima County water study (a multidisciplinary effort to develop policy to best use water resources), Canfield led the effort to determine how to most beneficially use stormwater. He developed a framework to decide whether stormwater capture (i.e. stormwater harvesting) or recharge are the best strategies at the regional watercourse, tributary watercourse, neighborhood and lot scales. This framework could be used to help communities determine how to better use rainwater and stormwater.

Canfield has been a member of many special committees and study teams on water resource management. These include:

- City of Tucson/Pima County Water and Wastewater Infrastructure, Supply and Planning Study, 2010: Member of Core Team.
- Low Impact Development/Green Infrastructure Workshop, March 15, 2011: Organizer.
- Governor's Blue Ribbon Panel on Water Sustainability, 2010: Member of Economic and Funding Working Group.
- City of Tucson's Water Harvesting Ordinance Development Standard, 2010: Member of Steering Committee
- Citizens Water Advisory Committee (CWAC) Tucson Water: Current Chair

Michael Crimmins, Associate Professor, UA Department of Soil, Water, and Environmental Science and Arizona Cooperative Climate Science Extension Specialist

In his position Dr. Crimmins provides climate science support to resource managers across Arizona by assessing information needs, synthesizing and transferring relevant research results and conducting applied research projects. His extension and research work

supports resource management across multiple sectors including rangelands, forests/wildfire, and water resources as well as policy and decision makers. This work aims to support managers by increasing climate science literacy as well as developing strategies to adapt to a changing climate. He also serves as a drought monitoring expert on the Arizona Governor's Drought Task Force and has worked with counties across Arizona to implement drought preparedness and impact monitoring plans.

Cado Daily, Program Coordinator Senior, Waterwise Program, UA Cochise County Cooperative Extension

Water Wise is a community-based water conservation outreach program educating water users and managers to demand less of stressed water supplies, and of recent, rely more on alternative, sustainable water sources such as rain and stormwater. Daily is a member of the national American Rainwater Catchment Systems Association (ARCSA), is an ARCSA Accredited Professional, is a former ARCSA Southwest Representative, developed and coordinated a multi-agency Tucson water harvesting conference, and is a member of the International Rainwater Catchment Systems Association. Daily has spoken at national and local water harvesting venues, and has developed numerous informational outreach materials on water harvesting. She received grant funding to create a water harvesting certification program in Sierra Vista and can bring a wealth of data and experience from the community projects. A short list of projects she has led includes:

- PI for a private foundation funded "RainScape Challenge Contest" that developed five landscapes to rely entirely on rain and stormwater harvesting as examples of a new concept in sustainable landscapes;
- PI on a TRIF funded "Rainwater Harvesting Certificate and Demonstration Program" project where Daily developed a community-based, hands-on water harvesting program;
- Assisted with a Coca-Cola funded "4-H2O" water harvesting project that funded the creation of seven youth-oriented water harvesting systems.

James MacAdam, Program Manager, Watershed Management Group's Green Streets/Green Neighborhoods Program

The Green Streets/Green Neighborhoods Program that James manages, conducts education, training, planning, and implementation of community-based, stormwater-harvesting green infrastructure in Arizona. James has led dozens of public workshops and professional trainings on stormwater/rainwater harvesting; and consulted with engineering firms, municipalities, and neighborhoods on green infrastructure design and implementation. He is the author of "Green Infrastructure for Southwestern Neighborhoods," the region's most comprehensive guide for retrofitting urban neighborhoods with small-scale stormwater harvesting practices. James serves as a principal member of the City of Tucson's Climate Change Committee, and serves on a multi-agency task force working to develop neighborhood-scale stormwater harvesting standards in the Tucson region. James is a LEED-Accredited Professional. James will share WMG's data and experience from leading hundreds of water harvesting implementation workshops, with thousands of participants, across a growing number of arid communities.

He is the author of, "Green Infrastructure for Southwestern Neighborhoods" found at <http://www.watershedmg.org/green-streets/resources> .

Mark Marikos, Senior Staff Technician, Utilities Management and Services, UA Facilities Management

Through his work as a member of the University of Arizona, Surface Water Working Group, Marikos has been involved in the planning and execution of several rainwater harvesting projects, both student and staff initiated. He has also contributed to review of construction design documents related to rainwater harvesting in the landscapes of new and remodeled buildings on campus. As the certified operator of record for the University's public water system, he has a vested interest in water conservation and harvesting to supplement landscape irrigation, and possibly industrial uses on campus.

Grant McCormick, UA Campus Planner, Planning, Design and Construction, Facilities Management

As the UA Campus Planner, Grant is involved in all aspects of planning, design and construction for stormwater and rainwater infrastructure for capture and use. He is a Landscape Architect by training. He serves on the UA Surface Water Working Group, teaches sections of the water harvesting course offered at UA, and participates on the City of Tucson's Landscape Advisory Committee (LAC) and the Urban Heat Island Workshop series.

Fernando Molina, Public Information and Conservation Officer, Tucson Water

Fernando Molina began at Tucson Water in 1991 as the Water Conservation Program Manager. He currently oversees the Public Information and Conservation Office. Molina holds a bachelor of arts in geography, with a minor in environmental sciences, from the University of Arizona. Prior to joining Tucson Water, he was a water resources specialist with the Arizona Department of Water Resources. The conservation office allocates \$186K in funding towards water harvesting education and projects. The office also oversees implementation of the new city ordinance requiring 50% of irrigation needs to be met with harvested rainwater on new commercial properties.

James J. Riley, Associate Professor, UA Department of Soil, Water and Environmental Science

Dr. Riley has a M.S. in Atmospheric Science and a Ph.D. in Hydrology from the University of Arizona. He has years of consulting experience in agriculture and water resources in arid regions around the world. His current focus is on water conservation issues in the Arid West. Since 2006 he has taught a water harvesting class at UA undertaking six class projects a year installing passive and active harvesting projects for schools and campus projects. He is a member of the UA Surface Water Working Group to design and install multiple-scale projects. He has also conducted water quality issues related to lead contamination in cisterns in the Tucson area. Riley is the author of several presentations and publications on water harvesting, including:

- Jordan, F.L., R. Seaman, J.J. Riley, and M.R. Yoklic, 2008. Effective Removal of Microbial Contamination from Harvested Rainwater Using a Simple Point of Use Filtration and UV-Disinfection Device. Urban Water.

- Riley, J.J., B. Lancaster, A. Audrey, G. McCormick, E. Scharf, and Chester Phillips, 2008. Rainwater, an important source of water for arid lands Catch it! Symposium on Rainwater Harvesting at annual conference of the Soil and Water Conservation Society, July 26-30, 2008, Tucson Arizona.
- Riley, J.J., B.G. McCormick, and D. Confer, 2010. Defining a New Paradigm for Management of Site-Generated Water Resources, with Emphasis on Rainwater Harvesting. Presented at the 23rd Annual Symposium of the Arizona Hydrological Society, Tucson, AZ, 30 August 2010.

Greg Shinn, Landscape Architect, GRS Landscape, Inc.

Greg Shinn has a Bachelors Degree in Landscape Architecture from the University of Arizona and is a registered landscape architect in Arizona and California. Currently, he owns a landscape architectural consulting business specializing in commercial, industrial and land planning projects. As part of this work, Greg evaluates water harvesting potential on sites and coordinates the preparation of rainwater harvesting plans for commercial developments. Over the past two years, Greg has been working with the City of Tucson's Riparian Protection Advisory Committee to rewrite the City's Riparian Protection Ordinance. As part of this task, the Committee is developing standards to enhance and restore riparian habitat utilizing harvested rainwater.

Ability to Accomplish Scope

Relevance of the Project to the LCC

○ Tucson lies in the Lower Colorado River Basin and is broadly representative of growing arid cities in the desert Southwest. The local history of water harvesting practices, a recent city ordinance for commercial water harvesting and innumerable projects implemented at residential, neighborhood and regional scales make Tucson an ideal case study for in-depth analysis on the cost-effectiveness of these practices. Practices in nearby municipalities such as Oro Valley, Phoenix and Sierra Vista and municipalities across the Southwest can help to broaden the picture. The affiliated AridLID 2012 conference workshop, to be held March 2012 in Tucson, will bring representatives from a broader geographical area including New Mexico, West Texas, California and Nevada. Ultimately, the project outcomes will be relevant nationwide, as it is clear that there is interest across the US for this type of information where communities deal with drought and the impacts of climate change.

○ The proposed project will augment ongoing activities within the geographic area of the LCC, but no current efforts directly address the needs of communities and water utilities for reliable information about rainwater and stormwater harvesting. Reclamation's Colorado River Basin Study encompasses many aspects of water management in the basin, but generally is focused on large-scale impacts and management strategies. It emphasizes understanding region-wide impacts and potential system-wide adjustments. Although the proposed project will look at a range of scales, a large-scale view in the context of the proposed project would be a metropolitan region rather than an entire river basin. It will also complement the efforts of the West-Wide Climate Risk Assessments by developing

information on a potentially important community-level climate adaptation strategy. In addition there are a few Reclamation funded grants that overlap in some way with the proposed project: These include Arid Cities in Changing Climates: Urban Land and Water Use in the Desert Southwest, Steve Yool, Chris Scott, Stephanie Beuchler, UA, School of Geography and Development, Sharon Megdal, WRRRC; and Tradeoffs of Enhanced Urban Runoff-Recharge and Water Quality, is finding out if pollutants, metals, pathogens and nutrients in storm runoff present a challenge to stormwater recharge. Erika Gallo, Post-Doctoral researcher, UA School of Natural Resources and the Environment. Other on-going projects may benefit in minor but potentially important ways from research under the proposed project, such as, Spatial Optimization for Regional Stormwater Infrastructure, Gary Woodard, Associate Director for Knowledge Transfer, UA Biosphere 2.

- The proposed project is intended to directly benefit the water management of communities in the Desert LCC by providing a potential tool to help water resource managers adapt to the changing climate and impacts on availability of water supplies. In water scarce regions there is frequently competition between human and environmental users of water. In these competitions, the environment is usually the loser. A water conservation strategy that makes use of in situ resources (rainfall), and rather than diverting water from its natural path, captures water from impervious surfaces for use on landscaping and related needs, is a strategy with the potential to turn competition into mutual benefits. Management of a range of natural and cultural potentially could receive benefits from better knowledge of the requirements and effectiveness of water harvesting.

- The result of the proposed applied research project will be useful to resource management immediately upon completion of the project. The information gathered and analyzed to develop the assessment tool and guidance will be of immediate use, while the prototype tool will likely require more refinement through testing on a wider range of communities and utilities in order to make it more easily transferable outside the context in which it is developed. However, the only way to create tool that is useful to managers is to work from the specific to the general, rather than trying to capture the general at one go. This is especially true when resources and time not likely to be sufficient for a large effort.

- The commitment of time by the Technical Advisory Committee members, along with the letters of support from others, amply demonstrates the support from resource managers and potential Desert LCC partners, such as Pima County and the Sonoran Institute. The following Letters of Commitment and Letters of Support are attached:

1. City of Tucson, Tucson Water Department by Fernando Molina and Ivey Schmitz
2. Pima County Regional Flood Control District by Evan Canfield and Suzanne Shields
3. University of Arizona Department of Soil, Water and Environmental Science by Michael A. Crimmins and Eddie Camacho
4. University of Arizona Department of Soil, Water and Environmental Science by James J. Riley and Eddie Camacho
5. University of Arizona Facilities Management by Mark Mariko and Chris Kopach
6. University of Arizona Planning, Design and Construction by Grant McCormick and Carolyn Watson

7. University of Arizona Cooperative Extension, Cochise County by Cado Daily and Susan Pater
8. The American Rainwater Catchment Systems Association (ARCSA)
9. Sonoran Institute by Emily M. Brott

○ Water utilities, stormwater management agencies, flood control agencies, and other public departments that obtain, deliver, or otherwise manage potable water, rainwater and/or stormwater in the urban environment of the Western US will be better able to evaluate the suitability and cost-effectiveness of implementing water harvesting strategies at various scales and identifying what the potential benefits and barriers may be. At best, rainwater and stormwater capture will reduce dependency on potable water supplies for irrigation needs.

There is support and commitment to the project from a range of entities:

- The American Rainwater Catchment Systems Association (ARCSA)
- The Sonoran Institute
- Watershed Management Group
- Pima County Regional Flood Control District
- City of Tucson
- University of Arizona Facilities Management

Dissemination of Results

- No spatially explicit information will be generated.
- It is anticipated that 2-4 peer-reviewed journal articles will be generated.
- It is anticipated that at least **(1)**1-2 formal presentations will be made at conferences for resource management professionals, such as Arizona Hydrological Society, Arizona Water Association, Arizona Riparian Council, American Water Resources Association, American Water Works Association; **(2)**1-2 formal presentations at academic disciplinary conferences, such as American Geophysical Union; **(3)**2-3 presentations to interested organizations and agencies, including one to the Rainwater Stormwater Professionals Network (which may be combined with a presentation in the WRRRC Brown Bag Seminar series); **(4)** 3-4 informal presentations to interested groups.

In addition, we expect individual TAC members may produce papers and/or make presentations to their organizations and others.

Other distribution outlets will receive notice of the research and a brief summary of results. These outlets include:

- WRRRC newsletter – a newsletter article will be published;
- WRRRC website and listservs (linked with Facebook and Twitter);
- WEES website and listserve (linked with Facebook and Twitter);

- Institute of the Environment website and newsletter;
- Arizona Cooperative Extension network - 15 counties and 5 Tribal Reservations;
- UA News – a new article will be generated and is likely to be published in the UA News electronic newspaper;
- ARCSA;
- Arizona Floodplain Management Association;
- National Association of Flood Plain and Stormwater Management Agencies;
- Arizona Association of Governments;
- American Planning Association, Arizona Chapter;
- American Society of Landscape Architects, Arizona Chapter

Readers and recipients of the announcement will be invited to go to the WRRC website and/or contact the WRRC for more information.

The WRRC has extensive experience in developing and carrying out targeted information dissemination projects and maintains a well-established and robust information dissemination program, which includes a variety of publications, sponsored events and a web presence, all designed to communicate effectively with specific audiences. The WRRC is looked to, within Arizona and more broadly, as an independent source of accurate and reliable information on water issues.

Connection to Reclamation Project Activities

- The proposed project would be closely allied with Conserve to Enhance (C2E), originally developed under a Reclamation grant. The water harvesting systems installed as part of the C2E pilot will save water for the direct benefit of the environment. In addition, data from the C2E pilot will be used in the proposed project. Reclamation sponsored climate and hydrologic change research (Colorado River Basin Project studies) will also be a source of data and information for the prototype assessment tool.
- The University of Arizona receives Central Arizona Project water, provided by Tucson Water, as part of the mix of water sources.
- The project is not on Reclamation project lands nor does it involve Reclamation facilities?
- Reclamation projects and activities are recently completed or on-going in the Lower Colorado River Basin, where the proposed project is planned to take place.
- The proposed work will contribute water to the Lower Colorado River Basin to the extent that the use of rainwater and stormwater conserves potable supplies. It is possible that some of the water harvested would have reached the Lower Colorado River; some if not most would have evaporated. The proposed study will begin to look at this issue, collecting available data and identifying data gaps.

Performance Measures for Quantifying Actual Post Project Benefits

The primary performance measures for quantifying post-project benefits will be expressions of interest in learning about, adapting and adopting the water harvesting assessment tool. A very brief survey will be sent to the dissemination list along with the announcement gauging interest in the prototype tool. In addition, managers who test the tool will be asked for feedback on their opinion of its **(1)** usefulness and **(2)** willingness to use the assessment tool and **(3)** advocate for its use within their organization

Environmental and Regulatory Compliance

The PIs will ensure that the project adheres to all requirements for human subjects research of the Department of Health & Human Services (HHS) and Office for Human Research Protections (OHRP) through the UA Institutional Research Board.

Environmental regulations are not applicable to this research.

Required Permits or Approvals

Not applicable

Funding Plan

The non-Reclamation share of project costs will be obtained from University of Arizona salary and fringe benefits contributions of State of Arizona funding. Salary contributions will also be made for the time of two members of the Technical Advisory Committee from their non-university employers, Pima County Regional Flood Control District and City of Tucson Water. Eight letters of commitment from cost-share partners were received prior to submittal of this proposal.

Funding Sources	Funding Amount
Non-Federal Entities	
1. University of Arizona Salary Funding	\$26,365
2. University of Arizona WEES Salary Funding	\$19,569
3. University of Arizona WEES Operational Funding	\$8,657
4. University of Arizona Indirect Cost on UA Match*	\$28,114
5. City of Tucson*	\$1,800
6. Pima County Regional Flood Control District*	\$2,063
Non-Federal Subtotal:	\$86,568
Other Federal Entities	\$0.00
Requested Reclamation Funding	\$86,567
Total Project Funding	\$173,135

No in-kind costs incurred before the anticipated project start date are included as project costs.

No funding was requested or received from other Federal partners.



PRS Cost Share Worksheet Supplement

PI Name	Susanna Eden & Jacqueline Moxley	Sponsor	USDI / BOR
Title	Utility Guide to Rainwater/Stormwater Harvesting as an Adaptive Response to Climate Change	Start/End Dates	11/01/2011 - 10/31/2013

Cost Sharing/Matching Personal Services (attach another sheet, if necessary):

Employee Name	% effort cost shared	Employee annualized salary	Budget Period (dates)	Payroll Account #	Cost Share Salary	ERE rate	Cost Share ERE	Total Cost Share Sal + ERE
Susanna Eden	7.2207%	58,000.00	11/01/11 - 10/31/13	582502	8,376.01	29.80%	2,496.05	10,872.06
Jacqueline Moxley	5.0000%	67,000.00	11/01/11 - 10/31/13	582502	6,700.00	29.80%	1,996.60	8,696.60
Sharon Megdal	0.9952%	155,000.00	11/01/11 - 10/31/13	123208	3,085.12	29.80%	919.37	4,004.49
James J. Riley	5.0000%	62,961.00	11/01/11 - 10/31/13	125824	6,296.10	29.80%	1,876.24	8,172.34
Michael Crimmins	1.6911%	82,000.00	11/01/11 - 10/31/13	126720	2,773.40	29.80%	826.47	3,599.88
Mark Marikos	5.0000%	46,997.00	11/01/11 - 10/31/13	118680	4,699.70	43.70%	2,053.77	6,753.47
Bailie Grant McCormick	1.1973%	68,812.00	11/01/11 - 10/31/13	211516	1,647.77	43.70%	720.08	2,367.85
Kathryn Daily	1.1973%	42,630.00	11/01/11 - 10/31/13	571020	1,020.82	43.70%	446.10	1,466.92
TOTAL PERSONAL SERVICES					34,598.93		11,334.67	\$ 45,933.60

Cost Sharing/Matching: Other Direct Costs (cost Sharing/matching in non-personnel categories is discouraged):

Cost Category	Description of Anticipated Expenditures	Account #	\$ Contributed
Capital equipment			-
Operations	General Operation Supplies	TRIF Monies	8,657.00
Travel			-
TOTAL OTHER DIRECT COSTS			\$ 8,657.00

TOTAL COST SHARING/MATCHING (Personal Services + Other Direct Costs): **\$ 54,590.60**

COST SHARING/MATCHING: F&A Costs

	Sponsor	UA Contributed
Total Direct Costs Base (TDC)	57,140.00	54,590.60
Less Capital Equipment	0.00	0.00
Less Student Fees/Stipends (NOT salaries or wages)	0.00	0.00
Less Graduate Student Tuition Remission	0.00	0.00
Less Tuition/Fees (non-GRA/GTA)	0.00	0.00
Less Facilities Rental (for off-campus sites)	0.00	0.00
Less Patient Care Costs	0.00	0.00
Less Portion of each Subaward over \$25,000	0.00	0.00
EQUALS Modified Total Direct Costs Base (MTDC)	\$ 57,140.00	\$ 54,590.60

Calculate A = UA Full F&A Rate X (Sponsor MTDC + UA MTDC)		Calculate B = Sponsor F&A Rate X Sponsor MTDC	
UA F&A Rate	51.50%	Sponsor F&A Rate	51.50%
X (Sponsor MTDC + UA MTDC)	\$ 111,730.60	X Sponsor MTDC	\$ 57,140.00
EQUALS A Total Project F&A	\$ 57,541.26	EQUALS B Sponsor F&A	\$ 29,427.10

TOTAL Cost Sharing/Matching: F&A Costs (A - B) **\$ 28,114.16**

TOTAL UA Contribution (DIRECT COSTS + F&A COSTS) **\$ 82,704.76**

Non-UA Cost Sharing/Matching (Third-Party: Attach Supporting Documentation) **\$ 3,863.00**

TOTAL UA and 3rd Party Cost Share **\$ 86,567.76**

Cost sharing/matching should only be included in a proposal budget when required by the application guidelines, and should never be volunteered. It is the responsibility of the Principal Investigator / Department Business Office to maintain auditable records of cost sharing and/or matching expenditures by verifying personnel time and keeping copies of expenditure documents for a period of up to five years after the grant terminates.

It is the PI's responsibility to ensure that all persons whose time is used as cost share are aware of their commitment and that their time directly benefits the project.

Principal Investigator Signature: Susanna Eden
PI signature may not be delegated.

Date: 7/29/11